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JP 630286331 A US 4630421 A

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(54) Abstract Title
Insulated, vapour-permeable, liquid-impermeable panel

(57) A structural insulated panel 50 is vapour permeable but liquid impermeable. The panel comprises a first layer of rigid insulation material 52 and a second layer of rigid, vapour permeable but liquid impermeable material 54. The panel 50 is fixable to a second similar panel by interlocking means on adjacent edges of the panels. A number of panels 50 may be arranged to form a building structure. The panels 50 may be wall, floor or roof panels.

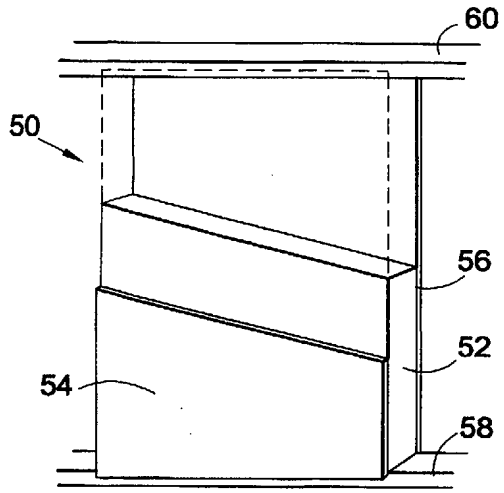

Fig.3

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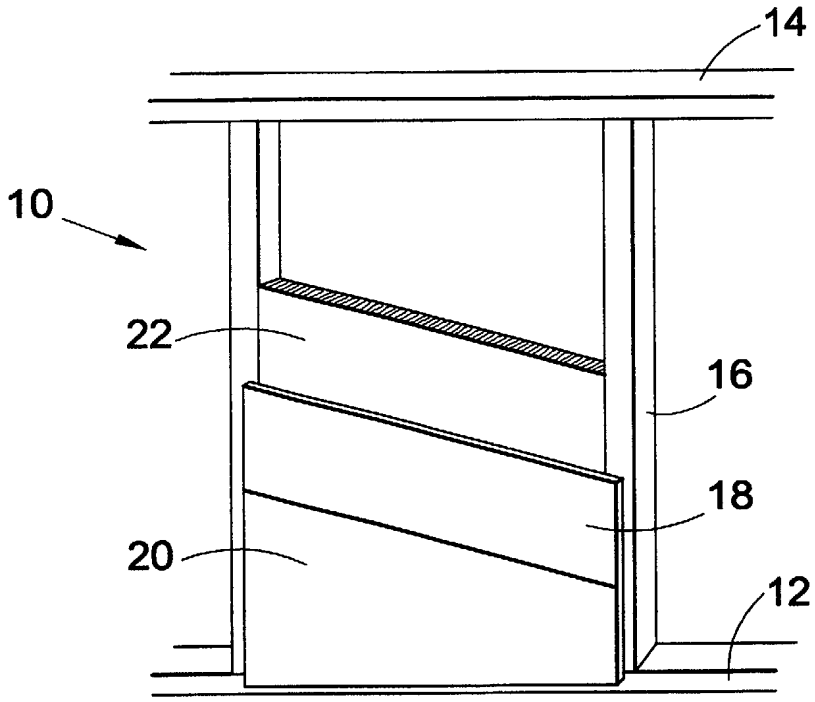

Fig.1
Prior Art

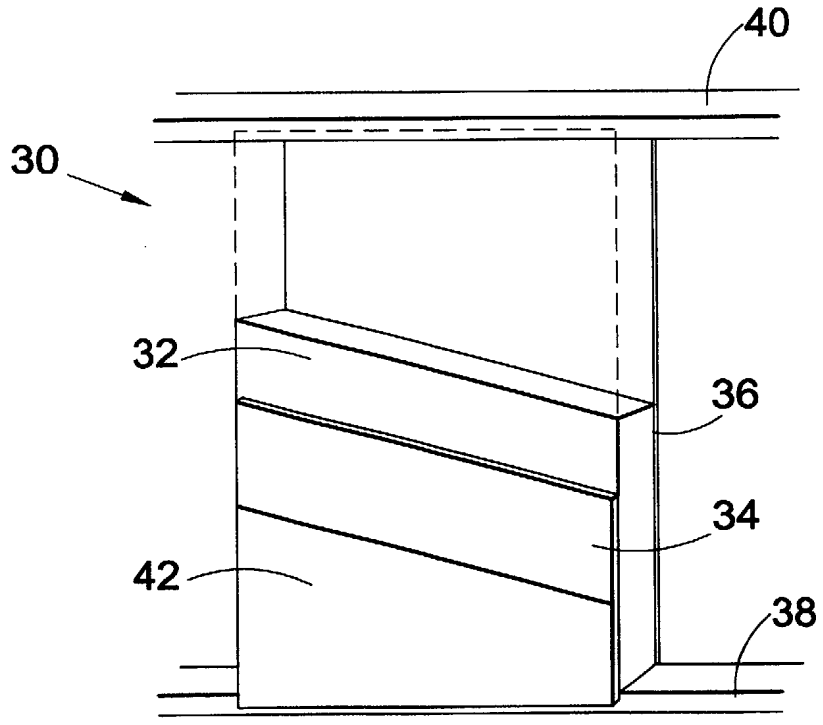

Fig.2
Prior Art

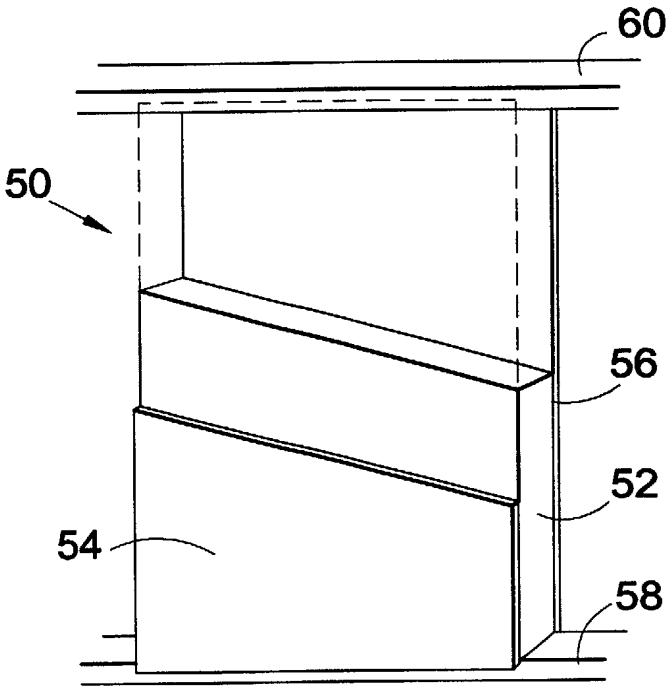

Fig.3

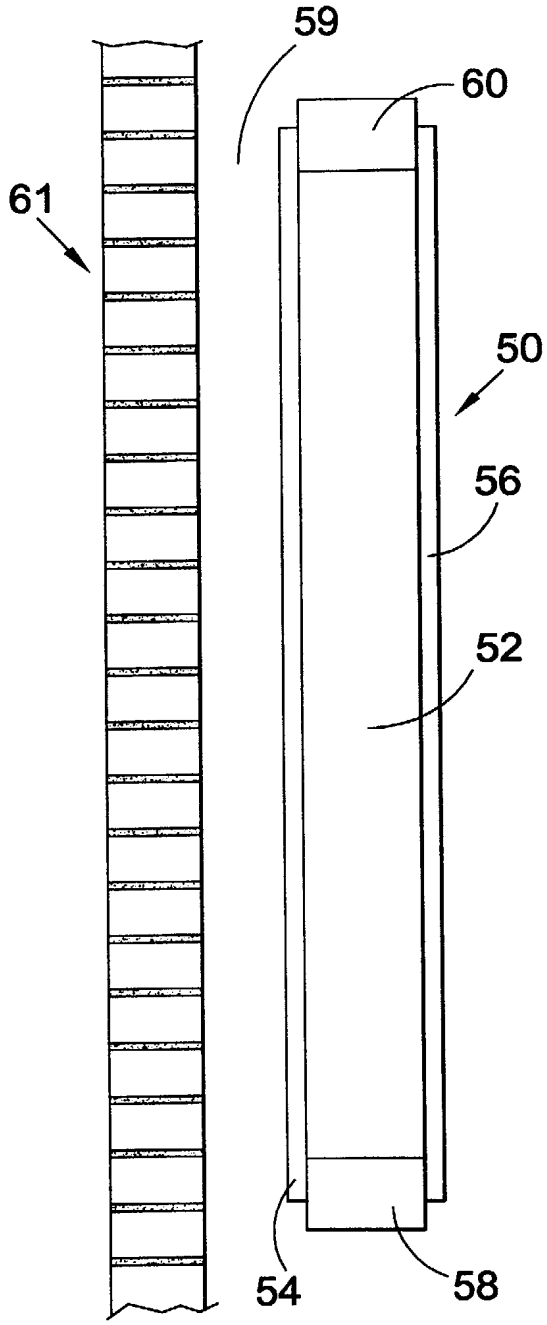

Fig.4

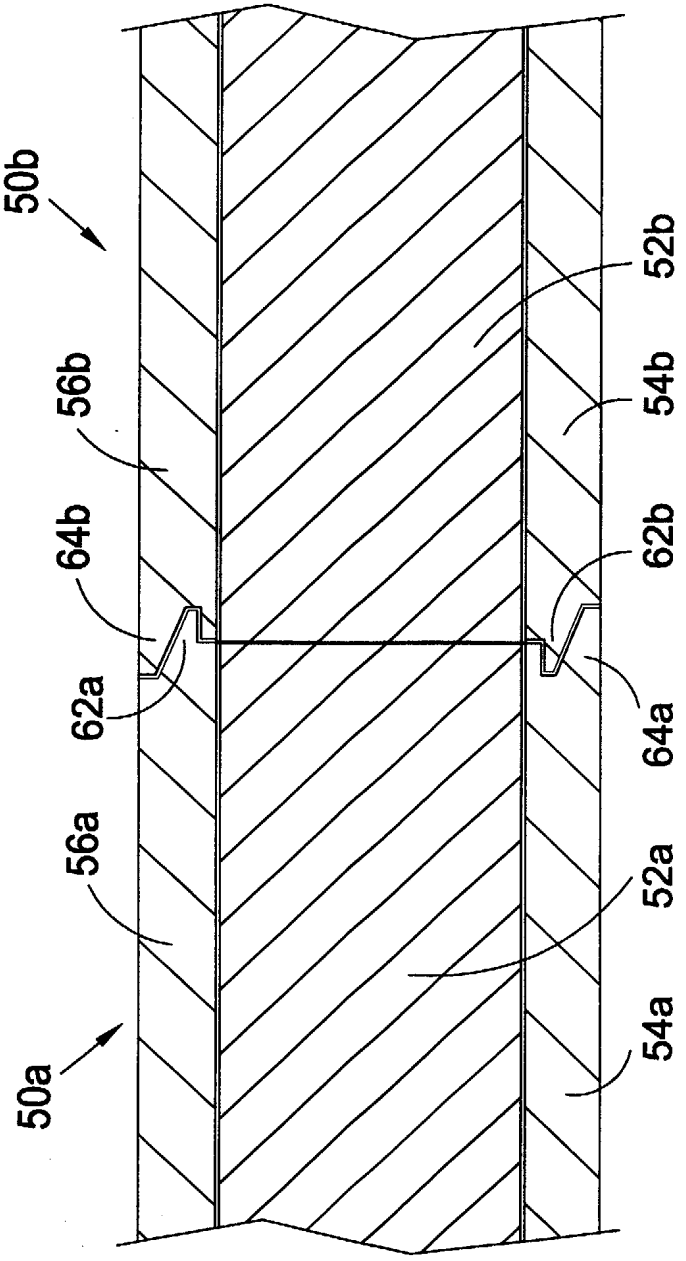

Fig.5

IMPROVEMENTS RELATING TO CONSTRUCTION

The present invention relates to construction of buildings, and in particular, though not exclusively, to vapour-permeable structural insulated panels (SIPs) eg. SIPs having a vapour-permeable outer layer.

Increasingly in the United Kingdom and elsewhere, walls (shells) of houses and other building structures are typically constructed using timber-frame technology. This normally involves providing a timber frame comprising horizontal sole plates and head binders and vertically placed structural timber studs faced with oriented strand board (OSB) or plywood. Between the studs and the boards is typically placed mineral wool insulation. However, structural timber frames must be assembled on site and are, therefore, labour intensive and expensive as a result of the on-site time required to build the frame.

In recent years structural panels manufactured from rigid insulation board (typically expanded polystyrene (EPS) sandwiched between two sheets of OSB or plywood), have been employed for constructing walls of building structures primarily in the United States of America. Such structural panels - often referred to as "Structural Insulated Panels" (SIPs) - provide certain advantages over conventional timber-frame technology.

However, building shells or frames constructed from both conventional timber-frames or from structural panels require to be protected from the elements, such as rain

water, during construction. This is usually sought to be accomplished by wrapping the frame or shell in a breathable flexible sheet form material or membrane which allows water vapour from inside the building shell to evaporate out through the breathable material but acts to prevent any ingress of liquid. However, the membrane - being a flexible sheet form member - can often tear during use, and flap in the wind.

Furthermore, to fix together known structural panels, it is required for a section of the insulating material to be removed and replaced with splines to secure the panels together. Such a fixing process is labour intensive, time consuming, and open to error.

Panels similar to available SIPs have been known and used in the United States of America for over forty years. Yet further escalating heating costs have led owners, occupants and tenants to demand greater thermal efficiency and improved energy performance in their buildings and homes. Governments are now working towards improving energy efficiency and taking steps to ensure that this will happen. At the same time, the building and construction market has become more competitive with accelerated construction schedules and shrinking profit margins and this is forcing builders, contractors and designers to look for more efficient and reliable construction methods that reduce labour and alleviate quality variables that plague conventional methods.

It is an object of at least one aspect of the present invention to obviate or at least mitigate one or more of the aforementioned disadvantages associated with the prior art and, particularly (though not exclusively) with existing structural insulated panels.

It is a further object of at least one embodiment of the present invention to provide a structural insulated panel which requires no internal frame within the panel, and wherein, in use, the panel itself acts as at least part of a building frame or shell.

These objects are sought to be addressed by a general solution of providing a structural insulated panel having means which act as a structural element of the panel and means which are substantially vapour permeable at least from one side but substantially liquid impermeable at least from another side.

According to a first aspect of the present invention there is provided a vapour-permeable structural insulated panel comprising a first layer of substantially rigid insulation material and a second layer of substantially vapour permeable but substantially liquid impermeable material, the second layer being disposed on or adjacent to a first surface of the first layer, and wherein, in use, at least one of the first or second layer is adapted to act as a structural element of the panel.

Preferably, the second layer is adapted to act as a structural element of the panel.

The panel may be adapted for use as a wall panel. However the panel may also be adapted for use as a floor panel, a roof panel, or the like.

The panel may comprise a third layer disposed on or adjacent to a second surface of the first layer.

This arrangement is particularly advantageous in providing a panel of a three-layer "sandwich" form which, in use, acts in an analogous way to an "I" beam. Preferably, therefore, the first, second and third layer act together as a structural element of the panel.

The second layer may be fixed in intimate contact with the first surface of the first layer.

The third layer may be fixed in intimate contact with the second surface of the first layer.

The second layer may comprise any suitable substantially rigid material, eg. fibreboard. Suitable materials available include: (highly) compressed stonewool, eg. available from Rockwool Rockpanel® such as Rockclad GT; a wood chip based material, eg. available from Fillcrete as Panelvent®; and preferably, Diffusible Humid-resistant Fibreboard (DHF)/medium density fibreboard, eg. available from E. Egger as Formline® DHF.

The first layer (or core layer) may be made from expanded polystyrene (EPS) or similar insulation material, eg. loose insulation such as glass wool, or rigid foam insulation such as polyurethane, extruded polystyrene, or phenolic foam.

The third layer comprise any suitable substantially rigid material, and may be made, for example, from oriented strand board (OSB), or alternatively from plywood, or from other rigid board materials such as listed above for the second layer.

Preferably, said first layer is fixed to said second and/or third layers using a suitable adhesive(s), eg. a PVA or polyurethane based adhesive such as, for example, Dorus MD074 available from Henkel.

A vapour-permeable structural insulated panel may be fixed to a second similar panel by butt-jointing and/or by use of one or more splines. Alternatively, adjacent panels may be fixed to one another by interlocking tongue-and-groove means carried on adjacent edges of the panels.

According to a second aspect of the present invention there is provided a building structure including at least one vapour permeable structural insulated panel, the panel comprising a first layer of substantially rigid insulation material and a second layer of substantially vapour permeable but substantially liquid impermeable material, the second layer being disposed on or adjacent to a first surface of the first layer, and wherein, in use, at least one of the first layer or second layer is adapted to act as a structural element of the building structure.

Preferably, the second layer is adapted to act as a structural element of the panel.

In one embodiment the building structure may comprise

a domestic dwelling house or a "light" commercial premises.

According to a third aspect of the present invention there is provided a method of forming a vapour-permeable structural insulated panel comprising the steps of:

providing a first layer of substantially rigid insulation material;

providing a second layer of substantially vapour permeable but substantially liquid impermeable material;

disposing the second layer on or adjacent to a first surface of the first layer so as to form the panel wherein, in use, at least one of the first layer or second layer act as a structural element of the panel.

According to a fourth aspect of the present invention there is provided a method of constructing a building structure comprising the steps of:

providing a plurality of substantially vapour-permeable structural insulated panels; and

arranging the panels so as to form at least part of a structural frame of the building.

According to a fifth aspect of the present invention there is provided a building structure including at least two structural insulated panels adjacent edges of adjacent panels being formed with interlocking means so as to position and retain adjacent panels in relation to one another.

The interlocking means may comprise releasably engageable interlocking means.

The interlocking means may comprise at least one tongue carried on an edge of a panel and at least one groove carried on an adjacent edge of an adjacent panel.

The panels may preferably comprise wall panels; though the panels may alternatively or additionally comprise floor and/or roof panels.

According to a sixth aspect of the present invention there is provided a structural insulated panel for use in a building structure according to the fifth aspect of the present invention.

In a preferred embodiment an edge of the panel carries a tongue at or near a first surface of the panel and provides a groove at or near a second surface of the panel.

The panel may be substantially vapour permeable but substantially liquid/moisture impermeable.

According to a seventh aspect of the present invention there is provided a method of constructing a building structure comprising the steps of:

providing at least two structural insulating panels;

placing the panels adjacent one another so that interlocking means formed on adjacent edges of the panel act to position and retain the adjacent panels relative to one another.

These and other aspects of the present invention will become apparent from the following description when taken in combination with the accompanying drawings, in which:

Figure 1 illustrates a prior art timber-frame wall

construction;

Figure 2 illustrates a prior art structural insulated panel (SIP);

Figure 3 illustrates a vapour-permeable structural insulated panel, in accordance with an embodiment of the invention;

Figure 4 is a side view of the vapour-permeable structural insulated panel illustrated in Figure 3; and

Figure 5 is a sectional side view of two modified vapour-permeable structural insulated panels illustrated in Figure 3 incorporating tough-and-groove interlocking means.

Reference is first made to Figure 1 of the drawings which illustrates a typical (inner) wall of a house generally denoted 10 constructed using timber-frame technology according to the prior art. Wall 10 comprises a horizontal sole plate 12 and a head binder 14 and vertically placed structural timber studs 16. Timber studs 16 are faced with oriented strand board or the like 18, the surface of which is typically finished with building paper 20. Between the studs 16 and boards 18 is typically placed mineral wool insulation 22.

Figure 2 illustrates a prior art structural panel generally denoted 30. Structural panel 30 comprises a first layer of substantially rigid insulation material 32 and on a first surface thereof, a second layer 34 of

substantially rigid oriented strand board. A third layer 36 comprising oriented strand board is provided against a second surface of substantially rigid insulation material 32. Panel 30 is fixed in position using horizontal sole plate 38 and head binder 40. A surface of the panel 30 intended to be internal the building structure is typically finished with building paper 42.

Figures 3 and 4 illustrates a structural insulated panel, generally designated 50, in accordance with an embodiment of the present invention. Structural insulated panel 50 comprises a first layer of substantially rigid insulation material 52, typically expanded polystyrene (EPS) or other suitable insulation material, and a second layer 54 of substantially rigid and at least partially vapour permeable but substantially liquid impermeable material. This second layer 54 is disposed on a first surface of the first layer 52 and affixed using a suitable fixing means such as an adhesive, eg. a PVA or a polyurethane based adhesive.

Materials suitable for use as the at least partially vapour-permeable but substantially liquid-impermeable second layer 54 are Diffusible Humid-resistant Fibreboard (DHF), eg. Formline RTM DHF, or alternatively a compressed stonewool material, eg. available from Rockwool Rockpanel RTM, or a wood chip based material, eg. Panelvent RTM. Formline RTM DHF is a medium density diffusible humid-resistant fibreboard suitable for structural purposes. It can be

used as sarking for roofs and wall sheathing. It is vapour-permeable, water draining and air tight providing heat insulation. The panel is available from E. Egger.

Rockclad GT from Rockwood Rockpanel RTM is manufactured from highly compressed stonewool. The panel is vapour permeable and weather resistant/water repellant. In addition, Rockpanel RTM materials are fire safe, dimensionally stable, easy to cut and fit, flexible, environmentally friendly and recyclable.

Panelvent RTM is manufactured from wood chips selected from wood waste and forest thinnings. This material is processed using a propriety system to produce long strand fibres. The water vapour transmission resistance is 1.47MNs/g, in contrast to plywood which has a mean of 4.78MNs/g. The panel has good vapour permeability, high racking strength (1.73 kn/m^{-}), weather resistant, satisfies requirements of a 60 minute fire (satisfies BS 476 : Part 21 : 1987 60 minute loadbearing wall fire test), breather paper is not normally required, thermal conductivity is low (0.08W/mK), easy to cut, has a bending strength of 22-30MPa, a tensile strength of 10-16MPa and air permeability of 0.02-0.03 m^{3}/m^{-}). The panel is produced to ISO 9001 and BS 1142. It is in compliance with BS 5268, conforms to BS 5250, and is available from Fillcrete.

Expanded polystyrene (EPS) comprises expandable beads of polystyrene pre-formed and fused together in a steam-heated mould under pressure. This produces a block of

material which is then cut to size and/or shaped. A variety of grades of material are available as defined in BS3837: part 1. These include standard duty, high duty extra high and ultra high duty. In addition, each grade is available as either normal (type N) or flame retardant (type A) which includes a flame-retardant additive. EPS has a high strength to weight ratio. Tensile strength ranges from 100 to 400 kPa, compressive strength ranges from 50 to 500 kPa, cross-breaking strength ranges from 50 to 500 kPa and design load ranges from 20 to 160 kPa for 1% nominal strain, with the exact properties all dependent on the particular grade and product.

A suitable adhesive is PVA Dispersion Glue for Assembly which is available from Henkel under the name of DOMS MD 074. This adhesive is waterproof, fast-setting and provides tough elastic joints.

Panel 50 may advantageously comprise a third layer 56 disposed on a second surface of the first layer 52. This third layer 56 generally comprises any suitable substantially rigid material such as oriented strand board or fibre board but may in a preferred embodiment be made from a same material as the second layer 54.

Oriented strand board is available under the trademark of Sterling OSB from CSC Forest Products Limited and from other manufacturers such as Louissenna Pacific, Egger, etc. A range of thicknesses from 6 millimetre to 25 millimetre are available in either square-edged or tongue-in-grooved

formats. The boards are manufactured from strands processed from trees averaging 78 millimetre long and 25 millimetre wide. The strands are dried, blending with resin binder and wax, and laid in a precisely oriented fashion to form large continuous mats.

During construction of a building shell, a panel 50 is placed upon horizontal sole plate 58 with the vapour-permeable but liquid impermeable material to an intended outside of the building shell. The panel 50 is held in place with head binder 60. Overlapping of sole plate 58 and head binder 60 by second layer 54 and third layer 56 secures the panel 50 to prevent movement in a substantially vertical direction perpendicular to sole plate 58 and head binder 60. Securing of panel 50 to prevent movement in a direction parallel to sole plate 58 and head binder 60 may usually accomplished using nails or the like driven through the sections of second layer 54 and third layer 56 which overlaps with sole plate 58 and head binder 60.

Illustrated in Figure 4 is a cavity wall including a panel 50, and a cavity 59 between the vapour-permeable second layer 54 and a conventional outer brickwork layer 61.

Panels 50 may be adjoined to one another by butt-joining, wherein a section of the insulation board is removed and splines approximately 100 millimetres wide are affixed to the oriented strand board layers 34 and 36 using screws.

Alternatively, as can be seen in Figure 5, vapour permeable structural insulated panels 50a and 50b can be secured to one another by interlocking tongue-and-groove edges 62a, 64b and 62b, 64a carried on adjacent ends of the panels 50a and 50b.

Openings for doors and windows may be excised from the panels 50 either during manufacture or construction.

It will be appreciated that in addition to wall structures, the panels 50 can also be used for roofing.

The panels 50 typically have a load bearing capacity suitable at least for domestic and light commercial use. The panels 50 may be used to support flooring joists, other panels 50, panelled roofs or roofing trusses or other elements of a building structure. Typically, a panel 50 may take a vertical load of the order of 12kn per meter run for a 2.7m high panel 50. Panels 50 can also be expected to be used for up to around 4m clear span in roof load situations depending upon a number of factors.

It will be appreciated that a principal advantage of the present invention is an ability to decrease the time for constructing building shells. Large sections of a wall are manufactured at a central location and construction only requires the erection of the pre-formed panels. The panels do not require any supporting frame - whether external to, or internal of, the panel - and are able to withstand the necessary loads. Furthermore, the use of vapour-permeable layer eliminates the need for securing a

protective membrane to the outer surface of the housing shell prior to the construction of the outer wall. Moreover, the use of the inter-locking tongue-and-groove joints between adjacent structural insulated panels allows panels to be secured together in less time and with less effort than would normally be required.

CLAIMS

1. A panel comprising a first layer of substantially rigid insulation material and a second layer of substantially vapour permeable but substantially liquid impermeable material, the second layer being disposed on or adjacent to a first surface of the first layer, and wherein, in use, at least one of the first or second layer is adapted to act as a structural element of the panel.

2. A panel as claimed in claim 1, wherein the second layer is adapted to act as a structural element of the panel.

3. A panel as claimed in claim 1 or 2 wherein the panel is adapted for use as a wall panel, floor panel, or roof panel.

4. A panel as claimed in any of the preceding claims, wherein the panel comprises a third layer disposed on or adjacent to a second surface of the first layer, the first, second and third layer acting together as a structural element of the panel.

5. A panel as claimed in any of the preceding claims, wherein the second layer is fixed in intimate contact with the first surface of the first layer.

6. A panel as claimed in claim 4 or 5, wherein the third

layer is fixed in intimate contact with the second surface of the first layer.

7. A panel as claimed in any of the preceding claims, wherein the second layer comprises a suitable substantially rigid material, selected from fibreboard, compressed stonewool, wood chip based material, or Diffusible Humid-resistant Fibreboard (DHF)/medium density fibreboard.

8. A panel as claimed in any of the preceding claims, wherein the first layer is made from an insulation material, chosen from expanded polystyrene (EPS), loose insulation such as glass wool, rigid foam insulation such as polyurethane, extruded polystyrene, or phenolic foam.

9. A panel as claimed in any of claims 4 to 8, wherein the third layer comprise a suitable substantially rigid material, chosen from oriented strand board (OSB), plywood, fibreboard, compressed stonewool, wood chip based material, or Diffusible Humid-resistant Fibreboard (DHF)/medium density fibreboard.

10. A panel as claimed in any of the preceding claims, wherein the first layer is fixed to the second and/or third layers using an adhesive.

11. A vapour-permeable structural insulated panel which is

fixable to a second similar panel by butt-jointing and/or by use of one or more splines.

12. A vapour-permeable structural insulated panel which is fixable to another vapour-permeable panel by interlocking tongue-and-groove means carried on adjacent edges of the panels.

13. A building structure including at least one vapour permeable structural insulated panel, the panel comprising a first layer of substantially rigid insulation material and a second layer of substantially vapour permeable but substantially liquid impermeable material, the second layer being disposed on or adjacent to a first surface of the first layer, and wherein, in use, at least one of the first layer or second layer is adapted to act as a structural element of the building structure.

14. A building structure as claimed in claim 13, wherein the second layer is adapted to act as a structural element of the panel.

15. A method of forming a vapour-permeable structural insulated panel comprising the steps of:

providing a first layer of substantially rigid insulation material;

providing a second layer of substantially vapour

permeable but substantially liquid impermeable material;

disposing the second layer on or adjacent to a first surface of the first layer so as to form the panel wherein, in use, at least one of the first layer or second layer act as a structural element of the panel.

16. A method of constructing a building structure comprising the steps of:

providing a plurality of substantially vapour-permeable structural insulated panels; and

arranging the panels so as to form at least part of a structural frame of the building.

17. A building structure including at least two structural insulated panels adjacent edges of adjacent panels being formed with interlocking means so as to position and retain adjacent panels in relation to one another.

18. A building structure as claimed in claim 17, wherein the interlocking means comprises releasably engageable interlocking means.

19. A building structure as claimed in claim 17, wherein the interlocking means comprises at least one tongue carried on an edge of a panel and at least one groove carried on an adjacent edge of an adjacent panel.

20. A building structure as claimed in any of claims 17 to 19, wherein the panels comprise of wall panels, floor panels, or roof panels.

21. A structural insulated panel for use in a building structure.

22. A panel as claimed in claim 21, wherein an edge of the panel carries a tongue at or near a first surface of the panel and provides a groove at or near a second surface of the panel.

23. A panel as claimed in claim 21 or 22, wherein the panel is substantially vapour permeable but substantially liquid/moisture impermeable.

24. A method of constructing a building structure comprising the steps of:

providing at least two structural insulating panels;

placing the panels adjacent one another so that interlocking means formed on adjacent edges of the panel act to position and retain the adjacent panels relative to one another.

25. A vapour-permeable structural insulated panel as hereinbefore described with reference to Figures 3 and 4, or Figure 5.

26. A building structure including a vapour-permeable structural insulated panel as hereinbefore described with reference to Figures 3 and 4, or Figure 5.

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Application No: GB 0110114.6 **Examiner:** Eleanor Wade
Claims searched: 1-10,13-14,15,23,25,26 **Date of search:** 30 October 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): E1D DF193, DCF, DLCQW

Int Cl (Ed.7): E04C

Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage			Relevant to claims
X	GB2319793	The Lets Group Ltd		1,3-6, 13,15,23
X	GB 2103997	Coolag Ltd.		1,4,5,6,23
X	JP63286331	Asahi Chem Ind Co Ltd	see abstract	1,3,4,5,6, 10,23
X	US 4630421	Diehl et al.		1,3,5,23

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

DERWENT-ACC-NO: 2002-374201

DERWENT-WEEK: 200409

TITLE: Vapor permeable structural insulated panel for construction of building, includes partially vapor permeable but substantially liquid impermeable layer affixed on surface of rigid insulation layer

INVENTOR: CUMMING D W; DANSKIN J F ; FORBES D C ; FORBES D S

PATENT-ASSIGNEE: CUMMING D W[CUMMI] , DANSKIN J F [DANSI] , FORBES D C[FORBI] , FORBES D S[FORBI]

PRIORITY-DATA: 2000GB-010187 (April 26, 2000)

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GB 2364338 B	January 28, 2004	EN

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PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
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INT-CL-CURRENT:

TYPE	IPC DATE
CIPS	E04B1/80 20060101
CIPS	E04C2/24 20060101

ABSTRACTED-PUB-NO: GB 2364338 A

BASIC-ABSTRACT:

NOVELTY - Panel (50) includes substantially rigid insulation layer (52) and partially vapor permeable but substantially liquid impermeable layer (54) which together functions as structural element of panel. The layer (54) made of diffusible humid-resistant fiber (DHF) board, is affixed on surface of insulation layer, using polyurethane-based adhesive.

DESCRIPTION - INDEPENDENT CLAIMS are also included for the following:

(a) Method of forming vapor permeable structural insulated panel; and

(b) Method of constructing building structure

USE - Vapor permeable structural insulated panel used as wall panel, floor panel, roof panel during construction of building, etc.

ADVANTAGE - Reduced time for constructing building shells. The panels do not require any supporting frames and are able to withstand necessary loads. The vapor permeable layer eliminates the need for securing protective membrane to outer surface of housing shell.

DESCRIPTION OF DRAWING(S) - The figure shows a vapor permeable structural insulated panel.

Panel (50)

Insulation layer (52)

Liquid impermeable layer (54)

EQUIVALENT-ABSTRACTS:

POLYMERS

Preferred Materials: The insulation layer of the panel is made of expanded polystyrene (EPS), loose insulation such as glass wool, rigid foam insulation such as polyurethane, extruded polystyrene or phenolic foam.

CHOSEN-DRAWING: Dwg.3/5

TITLE-TERMS: VAPOUR PERMEABLE STRUCTURE INSULATE PANEL CONSTRUCTION BUILD SUBSTANTIAL LIQUID IMPERMEABLE LAYER AFFIX SURFACE RIGID

DERWENT-CLASS: A93 Q44

CPI-CODES: A05-G01E; A12-R07;

ENHANCED-POLYMER-INDEXING: Polymer Index [1.1] 018 ; G0102 G0022 D01 D02 D12 D10 D19 D18 D31 D51 D53 D58 D76 D88 R00708 368; H0000; S9999 S1309*R; P1741; P1752;

Polymer Index [1.2] 018 ; P1592*R F77 D01; S9999 S1309*R;

Polymer Index [1.3] 018 ; P0226 P0282*R D01 D18 F30; S9999 S1309*R;

Polymer Index [1.4] 018 ; Q9999 Q6826*R; B9999 B4864 B4853 B4740; Q9999 Q6848 Q6826; Q9999 Q6893 Q6826; Q9999 Q9143; B9999 B5549 B5505; K9483*R; K9676*R; ND01;

Polymer Index [2.1] 018 ; P1592*R F77 D01;

Polymer Index [2.2] 018 ; Q9999 Q6826*R; B9999 B4864 B4853 B4740; Q9999 Q6848 Q6826; Q9999 Q6893 Q6826; Q9999 Q9143; B9999 B5549 B5505; K9483*R; K9676*R; ND01; Q9999 Q6644*R; N9999 N5721*R;

SECONDARY-ACC-NO:

CPI Secondary Accession Numbers: 2002-105942

Non-CPI Secondary Accession Numbers: 2002-292520